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JCB - do you know where original report is? George

~~I don't know either~~

See Aug 10, 1956 Memo This file

February 6, 1957

R+D/EP [redacted] MAR 1957 ~~Do you know?~~ OK 3/13

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Dear [redacted]

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Enclosed please find four copies of the report, "Addendum to Report Titled Problems Associated With The Use of External Transmitting Sources to Protect RS-6 Transmitters From Direction Finding".

If you require any additional information, please let us know.

Yours very truly,

[redacted]

[redacted]

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Vice President

DOC 13 REV DATE 18 MAR 1980 BY 064540
ORIG COMP 056 OPI 56 TYPE 01
ORIG CLASS S PAGES 8 REV CLASS C
JUST 22 NEXT REV 2010 AUTH: HR 70-2

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ADDENDUM TO REPORT TITLED "PROBLEMS ASSOCIATED WITH THE USE OF EXTERNAL TRANSMITTING SOURCES TO PROTECT RS-6 TRANSMITTERS FROM DIRECTION FINDING"

In view of recent developments, it has become necessary to add a third type of system to the two systems described in the original report. This new system was originally described in a paper titled "Continuous Monitoring for Voice Communication Jamming" by Dr. L. W. Orr and K. S. Watkins, presented at the Symposium on Electronic Countermeasures held in October, 1956.

Basically, the Continuous Monitor Jamming System, or CMJS, is a system for jamming an enemy's receivers while still monitoring his transmissions. In the CMJS, monitoring is done through the jamming rather than by reducing the jamming signal to a low level at the receiver site through the use of highly directional antennas and/or large separations between transmitter and receiver. As applied to the RS-6 transmissions, CMJS would permit jamming of enemy direction finding equipment while receiving the transmissions at a site relatively close to the jamming transmitter location. This would result in a considerable simplification over the two systems previously analyzed. However, estimates of other limitations such as the amount of jammer power required and the degree of protection given remain unchanged with the new system.

THE CMJ SYSTEM

The CMJ system consists of an FM jamming transmitter, the output of which also serves as the local oscillator for a "read-

through" receiver, "readthrough" being the process of reconstructing the modulation on the channel being jammed. The readthrough receiver consists of an untuned triode mixer which feeds an IF amplifier tuned somewhere in the frequency range from 30 to 40 kilocycles. The jamming signal and the signal being jammed are both fed to the mixer by the antenna. The jamming signal consists of an RF carrier frequency modulated by a sine wave of random frequency with the deviation (20 - 30 kc) carefully controlled so that the beats produced in the mixer will fall on the slope of the IF bandpass characteristic at the extremes of deviation. The output of the IF amplifier is detected and fed to a sampling gate. The sampling gate is operated by pulses from the FM modulator at each extreme of deviation, taking a 50 microsecond sample from the output waveform and storing it in a memory circuit.

If the signal being jammed is CW, the beat frequency fed to the IF amplifier comes to the same point on the slope of the IF characteristic at each extreme of deviation and the output of the sampling gate is constant. If the signal being jammed is FM modulated, the modulation is detected by the slope of the IF characteristic. If the signal being jammed is AM modulated, the amplitude of the IF output varies with the amplitude of modulation. In either case, the output of the sampling gate varies in amplitude and frequency in accordance with the modulation.

The memory circuit takes each of the output samples and

stores it until the arrival of a new sample at which time the old sample is erased and the new sample stored. The output of the memory circuit is thus a stepped waveform containing the quantized modulation envelope. The reconstructed modulation can be obtained by passing this waveform through a low pass audio filter. The degree to which the reconstructed modulation resembles the original depends largely on the sampling rate which must be high in comparison with the highest frequency to be reconstructed.

The above is a brief description of the operation of the CMJ system in the readthrough function. The experimental system actually contains two additional functions; "lookthrough" and "search". In the lookthrough function, the system output is displayed as a vertical deflection on an oscilloscope having a horizontal deflection linearly related to the frequency deviation. This display provides a means for accurately setting the jamming frequency on the channel being jammed and, to some extent, of observing the effectiveness of the jamming. In the search mode, the jamming power amplifier is turned off and the FM oscillator signal is injected directly into the mixer to give a sensitive display without radiation. At the same time, the deviation is increased and a mechanical frequency sweep set into operation to search a band of frequencies. Reference should be made to the original report for a more complete description of the system and its capabilities.

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RECEIVER-TRANSMITTER ISOLATION

While the CMJS does not require isolation between the jamming transmitter and the receiver to nearly the extent required in a system where the jamming signal must be below the minimum signal to be received, there will undoubtedly be some minimum isolation required, particularly in systems using high power jammers. The actual isolation required will depend on the maximum oscillator injection voltage that can be handled by the input stages of the readthrough receiver. An input stage consisting of an untuned triode mixer such as used in the system described in preceding paragraphs is capable of handling several volts of oscillator injection. The experimental system described by Orr and Watkins used loop antennas for the transmitter and receiver located 40 feet apart and was reported to give satisfactory operation with 100 watts of RF jammer power.

SENSITIVITY

The sensitivity of the experimental readthrough receiver was stated to be between one and two microvolts. However, no indication was made of the minimum field strength necessary for communications monitoring. Indications are that the CMJS sensitivity can be made comparable to normal receiving systems that are operable only in the absence of jamming.

JAMMING EFFECTIVENESS

The type of signal which is most effective against direction

finders is not exactly known. Presumably, a jamming signal of a type which will prevent the detection aurally or by field strength measurements of the presence of a signal would be the maximum requirement. A jamming signal sufficient to prevent reception at the direction finder of CW communications would meet this requirement. For such communications jamming, the FM by random sine wave used by the CMJS has been found to be less efficient than FM by random noise. Further development work is being done to remove the requirement that the frequency deviation be of constant amplitude so that FM by random noise and several other jamming signals can be used with the system. In attempting to reduce the effectiveness of direction finding, the use of CW code permitting lower modulating frequencies is strongly indicated as most desirable.

Some work has been done in developing a receiver using the CMJS output system to give a considerable improvement in communications through FM jamming. While techniques can be used with the CMJS to counteract such anti-jamming receivers, the present CMJS would be ineffective against receivers using this output system. Any program carried out to study the effects of jamming signals on direction finders should include the possibility of using such anti-jamming techniques with the direction finders.

COMPATABILITY WITH PRESENT SYSTEMS

The CMJS can be operated into any transmitting system

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presently capable of radiating an FM signal of the required bandwidth (approximately 40 kilocycles) without spurious AM, the spurious AM resulting in degeneration of the output quality of the system. The readthrough receiver requires a directional antenna separated sufficiently from the transmitting antenna and properly oriented to prevent overloading of the input stages. A simple tuned loop antenna should suffice in the frequency range from 3 to 8 megacycles. The maximum separation would be limited to the necessity to obtain sufficient injection voltage into the antenna and to maintain a stable phase relationship between the CMJS transmitter and receiver. Lines capable of carrying the transmitter modulating signal (audio frequencies) would be necessary between transmitter and receiver sites.

CONCLUSION

The Continuous Monitor Jamming System offers the possibility of considerable protection to RS-6 transmissions, both against interception of intelligence and direction finding, in areas where sufficient jamming signal strength is present. Although the present system is limited to jamming modulation types that are less than ideal, the system is still in the experimental stages and future developments are expected to correct this difficulty. Until anti-jamming measures are taken by the enemy, even the present system should work well. The system is capable of operating into existing RF power amplifiers and only a minimum separation is

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required between receiving and transmitting sites. High gain directional antennas are not necessary and only audio lines are required between receiver-control and transmitter-modulator equipments.

Respectfully submitted,

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By

Vice President

February 6, 1957

Prepared by:

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